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TWO-DIMENSIONAL GASES, LIQUIDS AND SOLIDS[1]

By Dr. IRVING LANGMUIR

ASSOCIATE DIRECTOR OF THE RESEARCH LABORATORY OF THE GENERAL ELECTRIC COMPANY

We live in a world of three dimensions. We measure objects by their length, breadth and thickness. The position of a point can be described by three coordinates, x, y and z. We can not escape from the inside of a spherical surface except by passing through it, but if we are standing in a circle on a surface we escape from it by stepping over it.

It is amusing to try to imagine a fourth dimension. We can reason that if we could travel into it, we could escape from the inside of a sphere without going through its surface.

In the special theory of relativity, Einstein has given us reasons for looking upon time as a kind of imaginary fourth dimension which differs from any of the ordinary dimensions of space much as the number one differs from the imaginary number $\sqrt{-1}$.

In the general theory of relativity, there are suggestions that the effect of gravitation is to warp four-dimensional space-time in a fifth dimension, very much as we have to warp a map of Europe to make it fit onto a globe representing the earth.

Poincaré in an interesting book, "Science and Hypothesis," attempted in 1903 to trace the probable development of science on the earth if it had happened that the earth's atmosphere, like that of Venus, had been perpetually cloudy. Without ability to observe the stars and sun, mankind would have persisted for long in a belief that the earth is flat. If a pioneer among scientists had made the statement that the surface of the earth has no edge or boundary but yet has a limited area, he would have been disbelieved; for these two statements seem contradictory to those who believe in a flat earth. The difficulty disappears, however, if it is recognized that the surface of the earth is bent into a spherical surface by being warped in a third dimension.

[1] Address delivered at the Mark Hopkins Centenary, Williams College, October 10, 1936.

When some forms of the relativity theory tell us that space has no boundaries and yet has a limited volume, we are similarly perplexed. The warping of our space in a fourth or fifth dimension, however, can remove these difficulties, at least for some people (the newspapers say ten).

Many of you perhaps have seen the little book entitled "Flatland," written in 1885 by an author who gives the name A. Square, but who is said to be Edwin A. Abbott. A race of people is pictured who live in two dimensions. One of the inhabitants argues that there can be no third dimension, just as we argue that there can be no fourth dimension.

Of course, no one can seriously maintain the existence of a real fourth dimension of space, which is like the three that we already are familiar with.

To-day, however, I propose to tell you of a real two-dimensional world in which phenomena occur that are analogous to those described in "Flatland." I plan to tell you of the behavior of molecules and atoms that are held at the surfaces of three-dimensional solids and liquids. The chemist has long described molecules that are held in this way on surfaces as adsorbed molecules. I will show you that we can have adsorbed films which really constitute two-dimensional gases, two-dimensional liquids and two-dimensional solids.

Hydrogen and carbon combine to form a very interesting class of substances called hydrocarbons. Most of these are stable and relatively inert. A good example of a compound of this kind is a substance called hexadecane, which has a formula $C_{16}H_{34}$, the carbon atoms being arranged in a long chain. Purified mineral oil, such as petrolatum, is a hydrocarbon having similar properties. It is not appreciably volatile and is insoluble in water.

When a drop of such a liquid is placed upon water, it floats on the surface as a lens which has a definite circular boundary where oil, water and air meet. Although the force of gravity tends to make the oil spread out over the water in a thin film, the lenses formed by petrolatum are about 4 mm thick. There must therefore be a force of considerable magnitude which prevents the oil from spreading. Measurements show that this force amounts to about 12 dynes per cm.

There are large numbers of oils and fats, however, which when placed on water spread out to form extremely thin films of the order of 10^{-7} cm thick. It is found that the general characteristic of all such substances that spread is that they contain in their molecules certain groups of atoms which have an affinity for water and are therefore called *hydrophilic*. The most common of these groups is the $-OH$ group or the $-COOH$ group. If such a group is substituted for one of the hydrogen atoms in each of the molecules of a lower hydrocarbon, the effect is to increase the solubility of the substance in water.

The substances that spread as thin films upon water are thus substances whose molecules possess a composite surface, most of the molecule having very little affinity for water, thus being *hydrophobic,* while another portion of the molecular surface is hydrophilic. By spreading on the surface of the water, the molecules can thus arrange themselves so that the hydrophilic portion of each molecule comes into contact with water without bringing the hydrophobic portion in contact with the water. In the common fatty acids, the COOH group is at the end of the long chain. Thus when the molecules spread over the surface of the water, they become oriented on the water so that they are approximately vertical with their heads (hydrophilic groups) in the water and their tails (hydrophobic groups) packed side by side above the layer that contains the heads.

Because of the affinity of the hydrocarbon parts of the molecules for each other, the molecules spread on the surface of the water only far enough for their heads to come in contact with the water. The surface tension of the water, therefore, is not decreased unless enough fatty acid is added to cover completely the surface with a monomolecular film. By measuring the volume of oil required to form a film covering a given area, the thickness of the film can be calculated. This thickness is evidently the length of the molecules, since these are arranged nearly vertically in the film.

By placing a known number of molecules on the surface and measuring the area to which the film spreads before the surface tension is lowered below that of pure water, the area per molecule can be measured. This gives the cross-section of the molecule. These experiments enable us to find the shapes of the molecules, and prove that the molecules of the higher fatty acids such as stearic acid $C_{17}H_{35}COOH$ in a film on water have a cross-section of about 20×10^{-16} sq cm or an average diameter of about 4.5×10^{-8} cm; while the length of the molecule is about 24×10^{-8}, or more than five times the diameter. This is quite in accord with the known chain-like arrangement of the carbon atoms.

Experiments of this kind are best carried out by using a large shallow tray which is filled to its brim with water. Movable strips of metal placed across this tray serve as barriers to confine the film that is produced by adding oil to the surface. To measure the force F per unit length which the film exerts on the barrier, one of the barriers is replaced by a floating strip of paper made waterproof by paraffin, which is attached to the vertical pointer of a balance placed above the tray. The leakage of the film around the ends of the floating barrier is prevented by connecting the barrier with neighboring points on the rim of the

tray by paraffined silk threads which float on the surface of the water. The balance is adjusted so that it reads zero when there is clean water on both sides of the barrier. A definite minute amount of a substance such as a fatty acid is placed on the water on one side of the floating barrier by applying measured drops of a dilute solution of the substance in a volatile solvent, such as benzene. The film is confined to any desired area by a second barrier which extends across the tray. Dividing the area between the fixed and floating barriers by the number of molecules which have been placed on the surface, we obtain the area per molecule which we denote by a. The weights which must be placed on the pan of the balance in order to hold the floating barrier in a fixed position give us the force F (per unit length) exerted by the film. By progressively changing the area by moving the second barrier, the force F may be measured as a function of a, the area per molecule.

An elementary experiment in physics consists of establishing the validity of Boyle's law (which states that the pressure of a gas is inversely proportional to its volume) by placing a gas in a cylinder in which there is a movable piston by which any desired force can be applied. An equation which expresses the pressure in terms of the volume and temperature is called an equation of state. For ideal gases it is found in this way that

$$pv = kT \tag{1}$$

where p is the pressure, v is the volume of the gas divided by the number of molecules, T is the absolute temperature, and k is a universal constant 1.37×10^{-16} when expressed in the usual units. It is sometimes more convenient to express this equation in terms of n, the number of molecules per unit volume of gas. The equation then takes the form

$$p = nkT. \tag{2}$$

I hope you see the close analogy between the experiments in which a gas is confined in a cylinder having a movable piston and the experiment in which we place a monomolecular oil film on the surface of water in a tray, which is provided with a floating barrier which can exert any desired force on the film. The floating barrier thus corresponds to the piston in the three-dimensional experiment. We may thus look upon an equation which gives F in terms of a as the equation of state for the two-dimensional film on the surface of the water.

The justification for regarding the film as having only two dimensions is that it consists of a single layer of molecules, so that the motions of the barrier do not cause the molecules to climb up on one another and so move into the third dimension.

With this concept of the molecules existing in a two-dimensional film, it is possible by well-established principles of thermodynamics to show that if the absorbed molecules do not exert any force on one another, they should behave as an ideal, two-dimensional gas; and that the equation of state of this two-dimensional gas should be given by

$$Fa = kT \tag{3}$$

where k has exactly the same value as is found for a three-dimensional gas. You see the form of this equation is the same as that of Eq. (1), the force F corresponding to the pressure p, the area per molecule a corresponding to v.

It is often convenient to describe a monomolecular film in terms of σ which may be defined as the number of molecules per unit area, which is evidently the reciprocal of a. Thus the equation of state can also be written

$$F = \sigma kT. \tag{4}$$

This equation is evidently entirely analogous to Eq. (2).

Films produced on water by non-volatile and insoluble fatty acids have properties which indicate that they are two-dimensional liquids and solids rather than gases, for they do not spread indefinitely; the value of F becomes practically zero when the surface concentration σ falls to some definite value. This is just what would happen in the three-dimensional experiment with the cylinder and piston when the cylinder is completely filled with a liquid. If we apply considerable pressure to the piston, the volume decreases only a very little; and if we lower the pressure, the volume does not increase indefinitely. The molecules of the two-dimensional film are held together by cohesive forces which originate from the interaction by the hydrocarbon chains, which by themselves tend to draw the film into a lens just as they do in a case of a pure hydrocarbon.

Solids and liquids in a three-dimensional world do not differ very greatly in volume or density nor in compressibility. The main difference is that a solid has the property of rigidity; that is, it can withstand shearing stresses. Oil films on water which are not two-dimensional gases can be described as condensed films, for the molecules are tightly packed against one another either because of external pressure or because of the cohesion between the molecules. These condensed films can exist in a solid or liquid state. This can be shown by their enormous differences in withstanding shearing stresses. For example, if particles of talc are dusted upon a liquid film, these particles circulate freely over the surface if one blows lightly upon the surface. In the case of solid films, however, the talc particles are held rigidly in definite positions

on the surface by the rigidity of the film. Many intermediate states can be observed, for example, where the talc particles will move only slowly even when a considerable force is applied by a strong blast of air. Such films evidently constitute a two-dimensional liquid of high viscosity.

We have recently constructed a simple apparatus to determine these mechanical properties of condensed films. A light aluminum disk is suspended at its center by a fine tungsten wire from a support which permits the rotation of the tungsten wire around its axis. This disk is lowered until it comes in contact with the surface of the water in the tray. An oil film is then placed on the water and subjected to any desired pressure by means of a barrier. The upper end of the tungsten wire is then rotated through a definite angle. If the film is liquid, the disk will also rotate through the same angle, and the length of time that it takes to do so is a measure of the viscosity. If the film has the properties of a two-dimensional solid, the rotation of the support will cause only a small elastic rotation of the disk, which corresponds to an angular displacement very much less than that of the support.

Experiments of this kind show that films of stearic acid on pure water, even if it is made alkaline by potassium hydroxide, are always liquid. Many previous investigators have found that such films on alkaline water are solid. It now appears that the observed rigidity was caused by extremely minute traces of impurities of divalent or trivalent elements in the water. One part in one hundred million of such impurities may be sufficient to make stearic acid films solid.

The films that I have been speaking of are those that form at the free surface of water; that is, at an interface between water and air. Such films have been quite extensively studied in recent years by a number of investigators.

If a thick layer of a pure hydrocarbon is placed upon water, the interface that forms the boundary between the hydrocarbon and the water is also a surface in which molecules can become adsorbed. The properties of these interfacial films are simpler than those of films on the free surface of water and exhibit in a more striking way the three possible states of a two-dimensional film (solid, liquid or gas). These films are also perhaps of greater fundamental interest, for their study throws light on many problems of biology, particularly those that characterize the walls of living cells.

The investigation of these interfacial films has been greatly facilitated by several new experimental techniques which have recently been developed by Dr. Katharine B. Blodgett. I can illustrate these by telling you what happens when a small amount of stearic acid is dissolved in a non-volatile hydrocarbon, such as petrolatum, and a drop of this is placed on alkaline water.

If only one part of fatty acid in several million parts of petrolatum is used, the drop remains as a globule on the surface; but the contact angle that the water makes with the oil gradually changes as the stearic acid slowly diffuses to the interface.

If one part in a hundred thousand is used, it is observed that the drop increases in size at first slowly, then with increasing rapidity; until quite suddenly it reaches a limiting size and stops spreading. The area to which the drop sureads is proportional to the amount of stearic acid that is placed in the drop but is independent of the amount of petrolatum that is in the drop. This proves that on alkaline water every molecule of stearic acid goes to the interface; the area per molecule is found to be 90×10^{-16}, or four and one half times as great as the area occupied by a stearic acid molecule in a condensed film on a free surface of water. If the drop of petrolatum containing stearic acid is allowed to spread on water which already has a film of stearic acid on it held under slight compression, the drop spreads to a considerably smaller area. Such experiments prove that the interfacial film has the properties of a two-dimensional gas which has an equation of state

$$F(a - a_o) = kT, \tag{5}$$

in which the constant k has the same value as it does in Eq. (3) and a_o has the value 57×10^{-16}. Such a correction to the equation of state for an ideal gas is exactly analogous to the correction in the equation of state for three-dimensional gases when allowance is made for the volume that is occupied by the molecules.

If now we increase the concentration of the stearic acid in the petrolatum still more so as to have a few parts per thousand instead of per hundred thousand, the drop of the solution when placed on the alkaline water spreads almost instantaneously to a film so thin that iridescent colors appear which are formed by the interference of light reflected from the upper and lower surfaces of the thin layer of oil. These colored films are very convenient to work with, for the color enables us to determine accurately the thickness t; so that, if we have solutions of known concentration n (molecules per cm³), we can calculate a by the equation

$$a = 1/nt. \tag{6}$$

The method of finding the thickness of the film from the color consists in matching the color of the film against that of a *comparison film*. A *comparison oil* was first made by oxidizing a white mineral oil, or

ven a lubricating oil, by heating it in an open dish n a hot plate until it smokes. During this process rops of oil are removed from time to time and placed pon a clean water surface. At first the drops form nses. As oxidation proceeds the lenses spread out to colored films. The oxidation is continued until he films become so thin that the color nearly disappears. A drop of known volume (from a calibrated ipette) is then placed on water in a large tray. By oving a barrier the area of this oil film can be deeased and therefore its thickness can be increased nd as this is done the color changes from the original aint yellow to a series of other colors. In this way he color can be brought to match that of any other olored film whose thickness it is desired to measure. This method furnishes us with an extremely accurate nd rapid method of measuring *a*, the area per molecule.

If the water upon which the oil globule is allowed o spread is acid instead of alkaline, the results are rikingly different. No spreading occurs at 25° C. nless the concentration of stearic acid in the petroatum exceeds 0.0032 parts by weight. For concenrations above this, however, the area to which the rop spreads increases linearly and very rapidly with he amount of the stearic acid in the drop. The rate f increase of this area with this concentration enables s to calculate the area per molecule by the equation

$$a = 1/(n - n_0)t, \tag{7}$$

where n_0 is the critical concentration which is just sufficient to cause spreading.

With water that is fairly strongly acid, at temperatures above about 25° C., the area per molecule is ound to be 53×10^{-16} cm², which is only a little more han half that observed with alkaline water. Measurements made with different external pressures applied o the film prove that this film is also gaseous and has n equation of state given by Eq. (5) with the value $a_0 = 20 \times 10^{-16}$.

The fact that a certain critical concentration n_0 is necessary on acid water before spreading begins indicates that the two-dimensional gas film at the interface s soluble to some extent in the petrolatum. We have here a case where the inhabitants of Flatland have learned to travel out into three dimensions. As long as they remain in Flatland they behave as a perfectly normal two-dimensional gas, but when they are crowded too much they escape into the third dimension and thus show an entirely different behavior.

On acid water at a lower temperature than a certain critical temperature of about 20° C the interfacial film of stearic acid condenses to a two-dimensional liquid, so that the area per molecule suddenly drops from 53 to 20. Very striking color changes are thus often produced by a change of a few tenths of a degree in the temperature of the water on which the oil is allowed to spread. This temperature thus corresponds to the boiling point of a two-dimensional liquid.

A comparison of these results with acid water and with water made alkaline with potassium hydroxide proves that the adsorbed molecules at the interface of alkaline water consist of molecules of soap, that is, of potassium stearate; whereas on acid water they consist of molecules of stearic acid. The large increase in a_0 from 20 to 57 units proves that the soap molecules surround themselves with a single layer of tightly bound water molecules; in other words, become hydrated; but this does not occur with stearic acid molecules.

Recently C. N. Moore and I have been investigating the intermediate field between acid and alkaline water, using solutions that are either neutral or very slightly acid or alkaline. We have also studied the effects of small amounts of calcium, magnesium, sodium and potassium salts in water. We find that in solutions which approximate closely to sea water in composition particularly interesting phenomena are observed. The area per molecule *a* and the value of n_0 which correspond to the solubility of the film are so remarkably sensitive to slight changes in acidity and alkalinity that the carbon dioxide of the air, which amounts to only a few hundredths of one per cent., produces great changes in these quantities. Sodium and potassium salts greatly increase the area per molecule and so make the film gaseous, whereas calcium and magnesium tend to bring this area down to 20 units and make the films solid. Calcium and sodium thus have an antagonistic action on the properties of these films.

The biologist has found that the permeability of the walls of the cells and many other properties are enormously affected by the ratio of the concentrations of calcium and sodium salts in the surrounding medium.

We are thus led to believe that interfacial films formed between a hydrocarbon which contains stearic acid and an underlying aqueous solution have properties which are in many respects very similar to those of a cell wall. In these experiments we have the advantage, however, that we can make this artificial cell wall cover a square foot if desired; we can study in detail properties which would be very difficult to measure on a living cell. By quantitative studies we can derive fundamental laws that govern these changes in properties. We hope by following up this work we shall be able to establish some principles that will be of great use to the biologist in understanding the complicated dependence of living cells upon the composition of the surrounding medium.

SCIENTIFIC EVENTS

A TECHNICAL INSTITUTION PLANT AND EQUIPMENT IN LONDON

THE formation of a Joint Advisory Committee representing three technical institutions, which has been set up to support the creation of a center in London for the inspection and purchase of plant and equipment for technical institutions, is announced in *Education*. The center will be at British Industries House, Marble Arch, London, W.1.

Manufacturers will be invited to display examples of equipment in sections, such as professional and scientific apparatus and supplies, laboratory apparatus, educational supplies, specialized furniture, tools, chemical and allied products, etc., and on the lower ground floor will be a Technical Institution Equipment Bureau which will be a key to sources of supply and a center for specialized information.

The object is to provide a convenient center for inspecting deputations and other buyers who at present have to visit colleges to see all that they want, and, even so, usually see only one example of a given range of equipment and can not always get information about prices, delivery and other business details.

It is expected that at first about eighty manufacturers will be registered in the bureau, so that, though this will be only the nucleus of those who will soon be participating, principals and other buyers are invited to send inquiries at once.

The Joint Advisory Committee considers that a really representative center, providing a ready view of various competitive examples of plant and equipment, will be a boon to members of local authorities, directors of education, principals and others who either buy or advise on the building and equipment of technical institutions. They think that it will become sooner or later an organic necessity.

Education points out that in view of the prevailing attitude of the Board of Education to technical education, inspecting deputations to the better-known technical institutions are very numerous. Loughborough, Willesden, South East London and others may well have two or three deputations a week. The deputations may remain till late in the afternoon and subsequently the principals may have to provide detailed information by correspondence.

The technical institution representatives on the Joint Advisory Committee are as follows. The Association of Technical Institutions: B. Mouat Jones, H. Schofield. The Association of Principals of Technical Institutions: F. J. Harlow, D. S. Anderson. The Association of Teachers in Technical Institutions: G. A. Robinson and J. Wickham Murray.

GRANTS OF THE AMERICAN ACADEMY ARTS AND SCIENCES

AT its October meeting the American Academy Arts and Sciences announced grants in aid of resea from its Permanent Science Fund, as follows:

To Professor James A. Beattie, Massachusetts In tute of Technology, $500 to provide a technical assist to enable him to make the necessary computations the evaluation of certain thermodynamic data obtai in an investigation of pressure effects on various ther metric scales;

To Professor Elery R. Becker, Iowa State Colle Ames, $500 for expenses connected with an investigati of the effects of food constituents on Coccidians;

To Professor Robley D. Evans, Massachusetts Instit of Technology, $500 for the purpose of purchasing paratus to be used in his study of radium poisoning;

To Professor J. Horace Faull, Arnold Arboret Jamaica Plain, Mass., $300 to aid him in making a to Guatemala and other southern countries to ena him to collect material on rusts that alternate betw coniferous, angiospermous and filicinean hosts;

To Dr. Millard F. Manning, University of the City Toledo, $125 toward the purchase of a computing m chine to be used in making theoretical calculations of electronic energy bands in metals;

To Professor R. K. Nabours, Kansas State College Agriculture, Manhattan, $350 to help defray his expe in collecting specimens of grouse locusts (Tetrigin in the regions around Tampico and Vera Cruz, Mexico;

To Professor Alden E. Noble, College of the Paci Stockton, $312 for technical assistance in the preparati of microscope slides and for work connected with stud on the trematode fauna of the marine fishes of Monter Bay, Calif.;

To Professor Thomas L. Smith, College of the Ozar Clarksville, Ark., $100 to be used in continuing studies of induced mutations in the wax moth, *Galler mellonella*, and

To Professor William F. Windle, Northwestern Unive sity Medical School, Chicago, $500 to aid him in emplo ing a technician in his study of the development of foet behavior as correlated with intrinsic growth of the nerv system.

In the cases in which the grants are for the emplo ment of technical assistants, it is understood that t work of the assistants is not to be taken in partial fu filment of the requirements for a degree. Applic tions for grants in aid of research will be receiv until March 15, 1937, by the Committee on the Pe manent Science Fund of the American Academy Arts and Sciences, for action at the March meeting the academy. Applications should be addressed Professor E. M. East, chairman, Permanent Scien

Fund Committee, Biological Laboratories of Harvard University, Cambridge, Mass.

TENNEY L. DAVIS,
Corresponding Secretary

SCIENTIFIC RESEARCH IN THE DEPARTMENT OF HOSPITALS OF THE CITY OF NEW YORK

THE executive committee of the Research Council of the Department of Hospitals of New York City at a recent meeting voted grants amounting to $7,875 for studies to be carried on in the Research Division of Chronic Disease, now functioning on Welfare Island, New York.

At the meeting, Dr. S. S. Goldwater, commissioner of hospitals, announced the completed organization of the scientific personnel, which includes:

Research Director, Dr. David Seegal, assistant professor in medicine, College of Physicians and Surgeons, Columbia University.

Clinical Associate, Dr. Arthur J. Patek, Jr., associate in medicine, College of Physicians and Surgeons, Columbia University.

Research Associate in Immuno-Chemistry, Dr. Forrest E. Kendall, assistant professor in biochemistry, College of Physicians and Surgeons, Columbia University.

Research Fellow, Dr. Dickinson W. Richards, Jr., assistant professor in medicine, College of Physicans and Surgeons, Columbia University.

Research Fellow, Dr. Kenneth B. Turner, associate in medicine, College of Physicians and Surgeons, Columbia University.

Resident in Research Medicine, Dr. Alfred Steiner, instructor in medicine, College of Physicians and Surgeons, Columbia University.

Resident in Research Medicine, Dr. James S. Mansfield, instructor in medicine, College of Physicians and Surgeons, Columbia University.

Studies which the Research Council is promoting include the following:

The mechanism of arteriosclerosis by Dr. Kenneth B. Turner and Dr. Alfred Steiner.

Pulmonary emphysema and fibrosis by Dr. Dickinson W. Richards and Dr. James S. Mansfield.

Cirrhosis of liver and hypertension by Dr. Arthur J. Patek, Jr.

The rôle of infection in chronic diseases with particular reference to chronic nephritis by Dr. David Seegal.

Chronic arthritis by Dr. Forrest E. Kendall and Dr. Martin Henry Dawson.

The Research Council of the Department of Hospitals was organized last year to stimulate scientific research in chronic diseases. Grants made by the council supplement the grant of $25,000 per annum made by the Board of Estimate and Apportionment for research work.

The officers of the Research Council for the current year are:

Marshall Field, *Chairman;* Dr. John A. Hartwell, *Vice-chairman;* Dr. Bernard Sachs, *Treasurer*, and Dr. S. S. Goldwater, *Secretary.*

The Scientific Advisory Committee includes:

Dr. Alfred E. Cohn, Rockefeller Institute for Medical Research.

Dr. Eugene L. Opie, professor of pathology, Cornell University Medical School.

Dr. W. W. Palmer, College of Physicians and Surgeons, Columbia University.

Dr. Alphonse R. Dochez, attending physician, Presbyterian Hospital.

Dr. Douglas Symmers, director of the Division of Laboratories of the Department of Hospitals.

Dr. William H. Park, director of Laboratories emeritus of the Department of Health.

Dr. Martin Henry Dawson is president of the Medical Board of the Research Division.

CENTENNIAL CELEBRATION OF THE AMERICAN PATENT SYSTEM

A CELEBRATION of the one hundredth anniversary of the American patent system will be held at the Mayflower Hotel, Washington, D. C., on November 23. At the invitation of Secretary Daniel C. Roper, of the Department of Commerce, Dr. Charles F. Kettering, of the General Motors Research Corporation, consented to be chairman of the committee in charge. The following program has been arranged:

NATIONAL ACADEMY OF SCIENCES AUDITORIUM—
10:00 A.M.

"Importance of Inventions to Civilization," by Dr. Harrison E. Howe, editor, *Industrial and Engineering Chemistry.*

"The American Patent System," by Thomas Ewing, a former commissioner of patents.

"The Great Inventions of the Century," by Dean Dexter S. Kimball, College of Engineering, Cornell University.

"This is Not the End—Looking Toward the Future of Invention," by Robert E. Wilson, vice-chairman, Pan American Petroleum and Transport Company.

2:00 P.M.

"Research Parade"—Demonstrations of scientific and technical principles and achievements which have not yet materialized into industrial applications.

DEPARTMENT OF COMMERCE AUDITORIUM—4:00 P.M.

Patent Office Society dedication ceremony.

DINNER PROGRAM—MAYFLOWER HOTEL

"Patented" Dinner.

"Mother Necessity," by the New York Theater Guild, Lawrence Langner, director.

Address by the Honorable Daniel C. Roper, Secretary of Commerce.

Address by the Honorable Conway P. Coe, Commissioner of Patents.

Toastmaster's address—Dr. Charles F. Kettering.

Radio program.

MAYFLOWER HOTEL BALLROOM

Patent Office Society dance.

RECENT DEATHS AND MEMORIALS

HENRY MINER EAKIN, director of the section of hydrodynamics of the Soil Conservation Service of the Department of Agriculture, died on October 20. He was fifty-three years old.

DR. LOWELL C. LLOYD, of the department of zoology of the University of Washington, died on October 7 at the age of thirty-two years.

PROFESSOR WILLIAM ARTHUR PARKS, formerly head of the department of geology and paleontology of the University of Toronto, and director of the Royal Ontario Museum of Paleontology, has died in his sixty-ninth year.

WILLIAM SOLLAS, for thirty-nine years professor of geology at the University of Oxford, died on October 22 at the age of eighty-seven years.

THE *Journal* of the American Medical Association states that a fund that it is hoped will amount to $100,000 is being solicited by Northwestern University to establish a foundation in memory of Dr. Howard Taylor Ricketts, who graduated from the Medical School in 1897 and who died in 1910 from typhus fever incurred in Mexico while engaged in a study of its mode of transmission. Dr. Ricketts was later associate professor in pathology and bacteriology at the University of Chicago. In 1910, the year of his death, he accepted an appointment as professor of pathology at the University of Pennsylvania School of Medicine.

SCIENTIFIC NOTES AND NEWS

THE American Public Health Association at its meeting in New Orleans awarded the Sedgwick Memorial Medal for distinguished service in public health to Dr. Frederick F. Russell, lecturer in preventive medicine and public health in the Harvard Medical School and in the Harvard School of Public Health, formerly director of the International Health Division of the Rockefeller Foundation.

BRONZE medals were presented to Dr. William J. Mayo and Dr. Charles H. Mayo at the twenty-first annual banquet of the Interstate Post-Graduate Medical Assembly of North America at St. Paul, Minn., on October 14. The presentation was made by Dr. David Riesman, of the University of Pennsylvania, president of the association.

THE University of Edinburgh conferred on September 17 the degree of doctor of laws on Dr. William Bowie, chief of the division of geodesy of the U. S. Coast and Geodetic Survey. Dr. Bowie was attending the meeting of the International Union of Geodesy and Geophysics at Edinburgh, of which he was president, when he received the degree.

PROFESSOR JOEL H. HILDEBRAND, of the department of chemistry of the University of California, has returned from abroad. He gave in September one of the introductory papers before the meeting of the Faraday Society at the University of Edinburgh. During his visit to Edinburgh he was elected to honorary life membership in the Chemical Society of the university.

DR. NORMAN L. BOWEN, petrologist of the Geophysical Laboratory of the Carnegie Institution of Washington, was recently elected a member of the German Academy of Science at Halle. Presentation of the diploma was made by the German Ambassador on October 14, at a luncheon given at the German Embassy in Washington.

AT the recent celebration of the centennial of Mark Hopkins at Williams College the degree of doctor of laws was conferred among others on President James R. Angell, of Yale University; President Karl T. Compton, of the Massachusetts Institute of Technology; President Livingston Farrand, of Cornell University; President Lotus D. Coffman, of the University of Minnesota, and President Mildred Helen McAfee, of Wellesley College.

PUBLIC celebrations were held on October 15 in Lynn and Detroit marking the fiftieth anniversary of the development of electrical resistance welding by Dr. Elihu Thomson. He was represented at Detroit by his son, Malcolm Thomson, a welding expert at the Lynn River Works of the General Electric Company, who read greetings from Dr. Thomson to the Detroit section of the American Welding Society. Following the

banquet was a radio talk from Lynn, given by Albert L. Rohrer, formerly electrical superintendent of the General Electric Company, who told of the experiments with which he helped Professor Thomson fifty years ago. The Massachusetts celebration included a dinner at Marblehead for a group of representative citizens of Lynn.

DR. ARTHUR MCCORMACK, of Louisville, Ky., health director of the State of Kentucky, was named president-elect at the New Orleans meeting of the American Public Health Association, succeeding Dr. Thomas Parran, Surgeon-General of the U. S. Public Health Service. He will take office a year from now. Other officers named were: Dr. Angel de la Garza Brito, of Mexico City, *first vice-president;* Dr. Robert E. Wodehouse, of Ottawa, Canada, *second vice-president;* Dr. E. M. Ehlers, of Austin, Tex., *third vice-president,* and Dr. Louis I. Dublin, of New York City, *treasurer.*

ALFRED E. GIBSON, vice-president of the Wellman Engineering Company, Cleveland, was elected at the Cleveland meeting president of the American Welding Society, succeeding J. J. Crowe, of Jersey City.

THE Ernest Kempton Adams fellowship at Columbia University has been awarded to Professor Shirley L. Quimby, Columbia University. He will investigate the elastic properties of single crystals in the alkaline metals. The fellowship has been held for the last three years by Professor Harold Clayton Urey, in recognition of his work on heavy hydrogen.

DR. THOMAS S. FISKE, professor emeritus of mathematics at Columbia University, has retired as secretary of the College Entrance Examination Board after serving for thirty-five years. He is succeeded by Professor George Walker Mullins, who has been for twenty-four years connected with the department of mathematics at Barnard College. A dinner in honor of Professor Fiske was given on October 27 at the Biltmore Hotel by members of the board, representing universities, colleges and secondary schools. Dr. Frederick C. Ferry, president of Hamilton College, was toastmaster. Dr. Nicholas Murray Butler, president of Columbia University, was among the speakers.

PROFESSOR JOHN A. MCGEOCH, chairman of the department of psychology at Wesleyan University, is serving as visiting professor on a part-time basis in the department of psychology at Clark University during the academic year 1936–37. He is giving one course at Clark in addition to his regular work at Wesleyan.

DR. JOSEPH C. HINSEY, professor of anatomy at Stanford University, has assumed his work as professor of physiology and head of the department at the Cornell University Medical School.

RALPH K. STRONG, head of the department of chemistry at Reed College, has been appointed to the same position at the Rose Polytechnic Institute.

DR. PAUL D. ISHAM, of the Massachusetts State College, has been appointed assistant chemist in the Bureau of Chemistry and Soils of the U. S. Department of Agriculture. He will be stationed at Pullman, Wash., where he will conduct research work on fruit and vegetables.

ACCORDING to *Industrial and Engineering Chemistry* James W. Kellogg, for nearly twenty-eight years a member of the staff of the Department of Agriculture of the State of Pennsylvania, has been appointed director of the Bureau of Animal Husbandry of the Iodine Educational Bureau, Inc.

DR. H. S. FAWCETT, professor of plant pathology at the Citrus Experiment Station of the University of California, has leave of absence for six months, to enable him to accept the invitation of the Brazilian government to assist in a study of citrus and other sub-tropical fruit diseases. He plans to leave for Brazil early in November.

DR. HENRY C. SHERMAN, Mitchell professor of chemistry at Columbia University, gave on October 27 a lecture before the New York University Chapter of Sigma Xi on "Problems and Progress in the Field of Nutrition." Dr. W. F. G. Swann, director of the Bartol Research Foundation, Swarthmore, Pa., will give the lecture on December 11. He will speak on "The Nature of Cosmic Ray Phenomena."

AT the Founders' Day exercises at Swarthmore College on Saturday, October 31, the address will be given by Dr. C. Stuart Gager, director of the Brooklyn Botanic Garden, on "Botanic Gardens in Science and Education." After the address, there will be inspection of the Arthur Hoyt Scott Arboretum and the collection of hardy chrysanthemums and other plantings on the college campus, under the leadership of John C. Wister, director of the Arthur Hoyt Scott Horticultural Foundation.

DR. EDWIN P. HUBBLE, of the Mount Wilson Observatory, gives the Rhodes Memorial Lectures at the University of Oxford on October 29 and November 12 and 26. The general title of the lectures is "The Observational Approach to Cosmology."

DR. WILLIAM A. PERLZWEIG, of Duke University, spoke recently at the School of Bacteriology of the Workers University of Mexico, on "Recent Advances in Clinical Chemistry in the United States."

THE Dohme Lectures at the Johns Hopkins School of Medicine will be given by Dr. Charles H. Kellaway, director of the Walter and Eliza Hall Institute of

Research in Pathology and Medicine, Melbourne, Australia, on November 5, 6 and 7. The titles of these lectures are as follows: "Snake Venoms; Their Constitution and Therapeutic Applications," "The Peripheral Action of Snake Venoms" and "Snake Venoms and Immunity."

DR. W. H. MILLS, lecturer in Jesus College and reader in stereochemistry at the University of Cambridge, England, has been elected George Fisher Baker non-resident lecturer in chemistry at Cornell University for the second term. Dr. William D. Harkins, MacLeish distinguished service professor at the University of Chicago, is lecturer for the first term.

THE Huxley Memorial Lecture of the Royal Anthropological Institute was delivered in the rooms of the Royal Society, London, on October 27, by Professor E. Westermarck. He spoke of "Methods in Social Anthropology."

THE autumn meeting of the National Academy of Sciences will be held at the University of Chicago on November 16, 17 and 18.

SECTION F (Zoology) of the American Association for the Advancement of Science will hold joint sessions with the American Society of Zoologists for the reading of papers and the giving of demonstrations at Atlantic City on Tuesday, Wednesday and Thursday, December 29, 30 and 31. There will be a dinner for all zoologists in the Hotel Ambassador on Wednesday evening, December 30. Following the dinner the vice-presidential address will be delivered by Professor Ross G. Harrison, of Yale University. The annual business meeting will immediately precede the business meeting of the American Society of Zoologists. Members of Section F who wish to present papers should communicate at once with Dr. H. B. Goodrich, secretary, American Society of Zoologists, Wesleyan University, Middletown, Conn., for full information regarding the conditions under which their papers may be placed on the program. No titles will be accepted by Dr. Goodrich after November 8. The secretary of the section is Professor George R. LaRue, department of zoology, University of Michigan, Ann Arbor, Mich.

THE fall meeting of the Pennsylvania Conference of College Teachers of Physics was held on October 16 and 17 at the Pennsylvania State College. Addresses were given by Dr. Saul Dushman, of the General Electric Company; Dr. L. O. Grondahl, of the Union Switch and Signal Company, and Professor F. B. Larkin, of Lehigh University. The general topic of the meeting was "Physics in Industry." Plans were made at this time for the spring meeting, which will be held at Franklin and Marshall College, Lancaster, Pa., on March 26 and 27. This will be a joint meeting with the Pennsylvania Academy of Science and the Lancaster Branch of the American Association for the Advancement of Science.

THE sixteenth annual meeting of the Highway Research Board will be held in Washington, D. C., during the week of November 16. Open meetings of departments of the board for informal discussion of current highway problems will be held on November 17 and 18. The regular annual board meetings will be held on November 19 and 20. There will be reports of various phases of highway development and construction which have been under intensive study during the past year; a discussion of the important rôle of soil in road work will be taken up at an informal open meeting to last all day on Tuesday; a symposium on stabilized soil for roads will be held on Friday. The departments of design and maintenance will join with the joint Committee on Roadside Development of the board and the American Association of State Highway Officials in an open meeting on Wednesday afternoon for the informal discussion of roadside problems of mutual interest. On Wednesday open meetings will be held by the departments of highway transportation economics, materials and construction. One session will be devoted to problems of highway traffic with particular reference to safety measures.

THE thirty-second annual convention of the National Association of Audubon Societies opened on Friday, October 23, at the American Museum of Natural History with a reunion dinner in the Bird Hall of the museum. The annual convention exhibit was held in the Educational Hall on Saturday. In addition to the exhibits of the society, the work of the U. S. Soil Erosion Service, the Biological Survey and the National Park Service was displayed and a collection of paintings of hawks by Major Allen Brooks was shown.

DUKE UNIVERSITY SCHOOL OF MEDICINE held its third annual symposium on October 15, 16 and 17. The subject was diseases of the heart, circulation and kidney. Sixteen physicians and surgeons participated in the program, representing the medical schools of Harvard, Virginia, the Johns Hopkins, Western Reserve, the University of North Carolina, Emory, the University of Pennsylvania, the University of Cincinnati, the University of Minnesota and the Mayo Clinic.

THE annual meeting of the committee on electrical insulation of the Division of Engineering and Industrial Research of the National Research Council, of which Dr. J. B. Whitehead is chairman, will be held at the Massachusetts Institute of Technology on No-

ber 5, 6 and 7. The subjects to be discussed are: e Theory of Dielectrics," "The Oxidation in In- ting Liquids" and "Insulating Materials and Prac- s."

HE Science Society of China held its annual meet- from August 17 to 20 at Peiping, under the aus- s of Tsinghua, Yenching and Peking Universities. of the constituent national societies, Botany, mistry, Geography, Mathematics, Physics, Zoology, at the same time. The total registration was ap- ximately 450 and about 250 papers were presented ore the different sections. Following the meeting, t-seeing trips were arranged to places of interest the Peiping area, including the Yung-kang caves Chou-kou-tien, the home of *Sinanthropos*, the ing man.

HE seventy-fifth anniversary of the completion of first transcontinental telegraph line was observed October 24 in the main building of New York Uni- sity, on the site where Samuel F. B. Morse, then a fessor of art, completed the construction of the t practical telegraph instruments. The ceremonies re arranged by the Oregon Trail Memorial Associa- n, of which Dr. Howard R. Driggs is president, in operation with New York University and the West- Union Telegraph Company. Historic messages re sent over the same lines that were used in the tial transcontinental hook-up. Employing instru- nts of that period, Western Union operators dis- tched Justice Field's message to President Lincoln. was carried over wires covering the exact route of original lines, through Omaha, Kearney and Scotts uff, Nebr.; Julesburg, Colo.; Casper, Wyo.; Salt ke City, Carson City, Nev.; Sacramento and San ancisco. Also transmitted over the original route s the message sent by Mayor Teschernacher, of San ancisco, to Mayor Wood, of New York City. A inting by W. H. Jackson was presented by Dr. iggs to Charles H. Carroll, general manager of the estern Union Telegraph Company, in appreciation the cooperation of the company in preserving oneer records.

SECURITIES valued at more than $1,000,000 have en given to Wesley Memorial Hospital, Chicago, by orge Herbert Jones, formerly president of the In- nd Steel Company. The money will be used for the st unit of a proposed new group of hospital build- gs to be erected at a cost of $5,000,000.

LORD NUFFIELD, motor car manufacturer, has made gift of £1,250,000 to the University of Oxford for e establishment of a post-graduate medical school. e has also promised a further £100,000 in reply to e university's appeal for an endowment for maintenance of the Bodleian Library and of new laboratories of physics and geology. This is said to be the largest gift received from an individual donor by a British university. In recent years Lord Nuffield, formerly Sir William Morris, has given over £1,000,000 to hospitals and other institutions.

SIR HENRY SOLOMON WELLCOME, governing director of the Wellcome Foundation, who died on July 25, at the age of eighty-two years, was the son of the Rev. S. C. Wellcome, of Wisconsin. He left an estate of the gross value of £2,138,959, with net personalty £2,065,063, on which estate duty of £968,754 has been paid. His will provides that all his personal effects and his collections of paintings, prints, books, manuscripts, historical objects and furniture in his residence or residences (not otherwise bequeathed) to his trustees, to be utilized for the furnishing and equipment of the museums, libraries or research bureaus, laboratories, etc., in England or elsewhere connected with the organizations of the Wellcome Foundation. He directed his trustees to pay, within 25 years of his death, to special trustees the sum of $250,000 for the library and auditorium with assembly rooms, park and sports field, etc., at Garden City, Blue Earth County, Minnesota, which he was having erected (in the names of his late brother, the Rev. George T. Wellcome and himself) as a memorial to their parents. And also, when opened for use, a further $150,000 as an endowment fund therefor, directing that the memorial should be known as "The Wellcome Memorial." The residue of his property he left in such shares as his trustees decide to and between and for the purposes of the following charitable objects: 1. "The Research Undertaking Charity," which is to be a fund for the advancement of research work bearing upon medicine, surgery, chemistry, physiology, bacteriology, therapeutics, materia medica, pharmacy and allied subjects which may conduce to the improvement of the physical conditions of mankind. 2. "The Museum and Library Charity," for a fund for the maintenance and/or extension of any of his research museums or libraries now in existence or any future such.

THE second Eli Lilly and Company Award in Biological Chemistry will be made at the 1937 spring meeting of the American Chemical Society in Chapel Hill, N. C., provided a suitable candidate for the prize is proposed. To be eligible, a nominee shall not have passed his thirty-first birthday on April 30, 1937, and shall have accomplished outstanding research in biological chemistry. The award is $1,000, $100 to provide a bronze medal for the recipient and $150 or as much thereof as may be necessary to defray the traveling expenses of the recipient to the meeting where he will receive the honor and give his address.

DISCUSSION

NOTE ON SCIENTIFIC WRITING

DURING the last six months I have analyzed from the point of view of their composition perhaps fifty scientific articles. My survey (if merely red-penciling errors and stylistic infelicities may be so dignified) was startling in its revelation of how badly a great many American scientists actually do write.

True, except for professional literary men, scientists probably write no worse than any other group of persons. But cumulatively their writings, even some of the most fugitive of them, are more meaningful and ultimately more valuable to society than are those of any other group. For that reason and for the wider diffusion of scientific achievement and thought, what the individual scientist has to say he should put in as simple, forceful, direct and understandable a manner as possible. Any deviation from that norm, by wearying and repelling readers, interferes with the widest communication and diffusion of scientific knowledge.

Several of the more frequently occurring of these deviations I wish to call to the attention of the scientists. All these errors add to the burden of the reader by forcing him to make needless and often trifling judgments. None of the errors, however, are very difficult to correct if the writer will pay conscious attention to overcoming them in his manuscript revision. Since I can not lay down any hard and fast rules, the best I can do is to illustrate with a few short examples chosen from the current writings of scientists. I use italics throughout to mark offending words.

THE EXCESS WORD

Nothing makes for more cumbersome, pedantic writing than the use of unnecessary words. For example:

> To-day in this country, as nowhere else in the world, we find government unequivocably on the side of the native. *That this is true is undoubtedly due in large measure to the fact that* the Indian is no longer a social or political force to be reckoned with.

The italicized words boil down to "undoubtedly because"; the two sentences become one. Of the fourteen words, twelve are unnecessary. Perhaps even the last phrase, "to be reckoned with," is a bit superfluous, too.

> The daily and weekly press supplies most of the reading matter for *many or most* of the world's population *from the high school age to the end of life.*

Better: The daily and weekly press supplies most of the reading matter for the world's adult population.

> Many biological processes . . . may be explained by the *influence which* environment *exerts* in furnishing . . .

Improved version: Many biological processes . . . may be explained by the influence of environment in furnishing . . .

> Examples *which may be cited that* are familiar *to you* are sunstroke, snow-blindness, and frost-bite.

Revised: Familiar examples are sunstroke, snow-blindness and frost-bite.

For example, in *the* tropical countries *of the world* . . . "Why *of the world?*" the alert reader will ask.

> The book is excellent and well adapted to the requirements of superintendents of parks, members of shade tree commissions, and others interested in conserving *those very important resources of the country known as* shade and ornamental trees.

The italicized words add nothing important.

> The conception on which it was founded was that there should be provided in Baltimore a place where young scholars attracted from various parts of the country might carry on advanced studies, *particularly with reference to the* development of scholarship and research. [. . . might carry on advanced studies and research.] At the beginning the group was small and the professors were chosen solely *with reference to* [for] the part they might play in this plan.
>
> There seems to be no intrinsic reason why a degree should be given for this study, but the degree has a certain commercial value, particularly *with regard to* [for] those engaged in teaching in secondary schools.
>
> *A greater degree of* [greater] international cooperation would bring about shifts in the use of land for the production of crops and livestock.

Phrases like *in relation to, with reference to, with regard to, in the case of, a greater degree of* usually mean that the writer has not sufficiently refined his thought. My suggested improvements are in brackets.

IMPERSONAL CONSTRUCTONS AND THE PASSIVE VOICE

Scientists apparently seek to efface themselves or to secure a tone of objectivity by resorting too frequently to impersonal and passive constructions. Example of the impersonal introduction to the main idea by the "There is . . ." or "It is . . ." construction:

> With the development of the science of genetics, *there has been a tendency on the part* of writers of text-books . . .

Better: With the development of the science of genetics, writers of text-books have tended . . . The italicized words delay the reader's understanding; the predicate-idea "tendency" comes before the subject-idea "of writers of text-books." The reader has to

make an added judgment in switching the order. Note also that seven fewer words convey the meaning.

Like the impersonal construction, the passive voice too often weakens scientific writing. Usually the active voice makes for a more effectively direct sentence. Too much passive voice in this example from a psychologist's article:

> For instance, a boy may be able to catch a ball, to dodge and to run. Ultimately it will be necessary for him to receive a punt with opposing ends bearing down upon him. In this total situation, account *must be taken* both of the ball and of the approaching ends. If only the ends *are perceived*, he is likely to fumble; if account only of the ball *is taken*, he is likely to be thrown for a loss.

Altered to active voice: . . . Ultimately he may have to receive a punt when opposing ends are bearing down upon him. In this total situation he must take account both of the ball and of the approaching ends. If he is aware only of the ends, he is likely to fumble; if he watches only the ball, he is likely to be thrown for a loss.

The passive voice frequently leads to vagueness. Notice the third sentence in the above excerpt. The words "account must be taken both of the ball and of the approaching ends" arouse the question, "By whom?" "By the boy" or "By the reader" are both good answers. In fact, I happened to take the second answer when I first read the paragraph, feeling that the writer was calling attention to the totality of the situation.

Mixed Figures of Speech

I am at a loss to account for the flair that scientists show for figures of speech, a great many of which they use badly. Either they have formed the metaphorical habit, trying as they must so often to see new concepts in terms of the old, or perhaps they feel that their writing requires some sort of "literary" adornment.

> These books put not emphasis but a wet blanket on one or all aspects of the evolution principle; and they often succeed in leaving only a pale ghost of our science in the student's hands.

What legerdemain can cover an aspect of a principle with a wet blanket and produce a pale ghost in a student's hands?

> . . . far more important than important new biological discoveries is now the matter of getting a great many more new *ultimate consumers for the body* of biological knowledge that is already at hand.

"Body of biological knowledge" is a perfectly good expression referring to the close, almost organic integration of biological knowledge. Doubtless a figure of speech originally, the phrase has no longer the force of a figure. When in this particular passage, however, the writer combines "ultimate consumers" with the idea of "body of biological knowlege," the latent, long-forgotten metaphor pops out. And for me at least, appears the picture of a maggot-infested carcass.

> . . . his influence was far-reaching through the activities of a considerable number of his students who were privileged to *bask* in the atmosphere of his enthusiastic leadership.

Bask connotes indolence, certainly not encouraged by enthusiastic leadership. A possible revision: . . . of his students who were privileged to work in the exhilarating atmosphere of his leadership.

> A hundred years of a germ of truth, or seventy-six years since its bloom in publication, has either catalyzed or attended a very wide-ranging body of facts relating worthily to the nature, origin, and destiny of man.

By way of contrast with the above, consider the effectiveness of a complex figure adroitly handled:

> Theory is the scaffolding of science, and just as in ordinary building operations, though some parts of it may be used for a short time before removal, others may function for so long a period that they may well be mistaken for the permanent structure itself.

In the hope that the individual scientist may profit at least slightly, I have called his attention to the most typical of the errors appearing in current scientific writing. In general, all men of science need to be constantly aware of the problems of written communication, since in reality the widest diffusion of scientific knowledge depends upon the written word.

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PHLOEM DEVELOPMENT AND BLOSSOMING[1]

As part of a study of why plants blossom, the idea is being developed that the reproductive state results from a similar physiological condition in different plant varieties, although very unlike or even opposite environments, as long- and short-days, are necessary to induce blossoming. It is being reported that an irregular rate of CO_2 exchange accompanies flowering in contrast to a more regular rate in non-flowering plants.[2] Also, that certain anatomical characteristics

[1] Published with the permission of the director of the Wisconsin Agricultural Experiment Station.

[2] R. H. Roberts, James E. Kraus and Norman Livingston. "CO_2 Exchange Rhythm and Reproduction." To appear in *Jour. Agr. Res.*

and a reduced cambial activity accompany flowering.[3] The further similar observation has been reported that the condition of the phloem appears to be particularly correlated with blossoming in a number of dicotyledonous plants.[4] These represented a wide range of reproductive habits.

Some of the phloem characteristics which have been seen to accompany blossoming are: (1) Limited or slight formation of phloem cells following reduced cambial activity which precedes blossoming; (2) small size of later formed cells; (3) increase in cell wall thickness; (4) increase in callose formation on sieve plates and fields; (5) accumulation of inclusions in some cells; (6) mechanical compression.

These various characters appear in unequal degree in different plant species or varieties. For example, the fruitful branches of the ornamental lemon are characterized by much callose formation; the stems of blossoming *Chrysanthemum* by small secondary phloem cells; or the stems of fruiting *Phaseolis vulgaris* by very little phloem.

It also seems significant that plants which produce an abundance of flowers, as the precocious *Begonia semperflorens,* have a very slight development of phloem. In contrast to this group, those which rarely flower, as the variegated *Vinca major* in the greenhouse, have an abundance of phloem tissue.

The conditions of the phloem tissue which accompany blossoming appear to have their effects in much the same manner as artificial girdling. In fact, the question may properly be asked if blossoming is not the result of "natural girdling."

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THE BLACK WIDOW SPIDER

THE only spiders, excepting the Tarantulas, which have gained a wide and infamous reputation are species of *Latrodectus,* a genus of the family Theridiidae. Wherever these spiders occur all kinds of conflicting stories are current among the peoples. There are authentic reports of serious and disagreeable symptoms even fatal results from the bite of these spiders as well as equally authentic reports of bites causing no harm. The contents of the poison sac are controlled by muscular action, probably voluntary on the part of the spider. Thus a bite may be harmless or not, depending upon the amount of venom injected.

Within recent years the literature concerning the common American species (*Latrodectus mactans* Fabr.), the black widow, has greatly increased. It seems that during this time the spider has greatly extended its geographical range. In the United States it first attracted attention in the South and was thought to have a southern distribution only. Cases of arachnidism or spider poisoning have seemed to increase during recent years. In the majority of cases the spider concerned has been the black widow. Therefore its distribution and various activities have attracted attention.

The first comprehensive study and compilation of the literature was that of Bogen.[1] From this work the distribution of the spider could be ascertained, and it was noticeable that it had not been reported from any of the midwestern states.

The next work which gave the distribution of this arachnid was that of Burt.[2] This worker added to the distributional records of Bogen, but still the spider was not recorded from the states of the upper Mississippi valley. A few states on the east coast and Oregon on the west were not represented. Since the spider has such a general distribution one could be practically certain that it occurs in all the states. Nevertheless, the only authentic, scientific records should be based on actual specimens from a definite locality and accurately determined.

The present writer wishes to record this spider (*Latrodectus mactans* Fabr., det. W. M. Barrows) from the following localities in southern Illinois: 1 female, Flora, October 1, 1934 (E. Booker); 1 male, Thebes, December 5, 1934 (H. H. Ross); 1 male, Carbondale, May 30, 1935 (H. H. Ross and C. O. Mohr).

In addition to these records Mr. W. P. Flint has very kindly furnished the following ones from his files in the Section of Economic Entomology of the Illinois Natural History Survey: Bellville, September 24, 1934; Flora, October 4, 1934; Jerseyville, November 6, 1934; Irvington, November 12, 1934; Edwardsville, July 12, 1935 (Alfred Rant); Barry, September 28, 1935 (R. L. Poppenhager). The sex or number of specimens was not indicated. As in the previous paragraph all localities are in Illinois.

The writer desires at this time to mention a few additions to the literature of the black widow which have been made since the bibliographies of Bogen and Burt.

A circular[3] has been published from the Oregon Agricultural Experiment Station which records the spider from that state and gives general information. It is mentioned as being most numerous in the eastern portion of the state. Thus this spider has now been recorded from every state west of the 100th meridian.

[3] Ocra C. Wilton and R. H. Roberts, *Bot. Gaz.*, September, 1936.

[4] R. H. Roberts, "A Discussion on Fruitfulness." Conference of Pacific N. W. Horticulturists, Entomologists and Plant Pathologists, Bozeman, Montana, July 15, 1936.

[1] *Anns. of Internal Medicine*, 6: 375, 1932.

[2] *Jour. Kans. Ent. Soc.*, 8: 117, 1935.

[3] *Oregon Agric. Expt. Station, Circ.* 112, 1935.

nother recent study has been published from the fornia Agricultural Experiment Station.[4] This ews the life history and gives general information. same general remarks will apply to W. J. Baerg's lication[5] from Arkansas. This includes a bibliog- hy.

he most comprehensive study which has appeared is that of D'Amour[6] *et al.* from Colorado. These workers consider the spider and its venom rather thoroughly, and their paper should be read by all who are interested in the black widow and its activities.

LEE H. TOWNSEND

ILLINOIS NATURAL HISTORY SURVEY
URBANA

REPORTS

HE RESPONSIBILITY OF ENGINEERING

RESIDENT ROOSEVELT has addressed to Dr. Karl T. mpton, president of the Massachusetts Institute of hnology, and to the heads of other schools of techogy and engineering an open letter that reads:

vents of recent years have brought into clearer perctive the social responsibility of engineering.

n respect of wise use of natural resources such rets as those of the Mississippi Valley Committee, the tional Resources Committee and the Great Plains ought Area Committee have brought out the facts imssively. The enclosed report, "Little Waters," prets in miniature many of the social-engineering probs of soil and water conservation.

n respect of the impact of science and engineering n human life—social and economic dislocations as l as advance in productive power—the facts are reled with distressing clearness in public records of mployment, bankruptcies and relief. The responsiity of scientists has been analyzed in noteworthy adesses such as, among the most recent, those presented the Tercentenary Celebration of Harvard University d the meeting of the British Association for the Adcement of Science.

The design and construction of specific civil engiering works or of instruments for production represent ly one part of the responsibility of engineering. It st also consider social processes and problems, and des of more perfect adjustment to environment, and st cooperate in designing accommodating mechanisms absorb the shocks of the impact of science.

This raises the question whether the curricula of engiering schools are so balanced as to give coming generans of engineers the vision and flexible technical capacity essary to meet the full range of engineering responsility.

I am calling this matter to the attention of educators high administrative authority in the hope that it may thoroughly explored in faculty discussions and in meetgs of engineering, educational and other pertinent prossional associations.

To this letter President Compton made on October 3 the following reply:

In response to your challenge to educators to give dents the necessary "vision and flexible technical capacity," and to engineers to "cooperate in designing and accommodating mechanisms to absorb the shocks of the impact of science," I am sure you will be pleased to know that these are already matters to which progressive educators and engineers have been giving most earnest and constructive attention through their schools and professional organizations. To this end, for example, increasing emphasis is being placed upon fundamentals rather than specialties in undergraduate engineering education, and there has been a notable increase in attention to the study of economics and social science.

I can not but wonder why your exhortation has been directed specifically toward engineers, for surely we would agree that similar breadth of knowledge and training is also urgently desirable among business leaders, economists and politicians—as is also thorough training in fundamentals. For example, there is a tendency in some quarters to make science the major scapegoat of our social ills, from which social planners will rescue us. What are the facts?

Just before the advent of the machine age, social planners were devising resettlement projects and model industrial communities based upon a scheme to employ labor of all children above the age of four years. This was their best solution of the desperate struggle of the masses of the people for the bare necessities of life. Since that time science and engineering have so increased productive power that it has been possible for enlightened public leaders to inaugurate a great program of social security, including child labor laws, universal education, moderate hours of labor, pensions, insurance and unemployment relief on a large scale. These are superimposed on an enormously improved general standard of comfort, health and interest in living. Such achievements of science dwarf into insignificance the "social and economic dislocations" to which you refer, unfortunate as these are and much as these merit the attention which you recommend.

One significant fact is generally unrecognized by those who are chiefly impressed by the fact that science, through machine production, has displaced human labor. It is that such machines are, by and large, products of a relatively old branch of science, mechanics, whereas the present day activities in science are principally in electricity, chemistry, metallurgy, biology and such newer branches as lead to new knowledge, new products, new industries, new employment and improved health and material welfare.

[4] *California Agric. Expt. Station, Bull.* 591, 1935.
[5] *Arkansas Agric. Expt. Station, Bull.* 325, 1936.
[6] *Quart. Review of Biology,* 11: 123, 1936.

There are two basic methods of dealing with "unemployment, bankruptcies" and similar dislocations which you mention, one palliative and the other curative. Both may be needed. The former includes relief, emergency work, and regulation, and operates immediately; the latter aims at creation of new employment, new wealth and new values, and is a longer range program. It is primarily to the latter that engineers and scientists are devoting their major attention, since both logic and past experience demonstrate its social effectiveness, and since it can only be carried on through their type of knowledge and training. Quite properly and of necessity it is the first method which has been the chief concern of the government, since the emergency called for swift action.

We engineers and scientists, however, are disturbed lest the palliative measures be mistaken for the cure, and lest the attention and money devoted to relief and regulation should interfere with simultaneous adequate attention and support to the basic contributions which our sciences can certainly make if given a chance.

As illustrations of our cause for concern, and of the need for broader understanding by political leaders as well as engineers, I would respectfully refer to four events. (1) The engineering and scientific organizations of the country combined to urge that a small portion of the public works expenditures be devoted to research aimed at better designs and materials for public works for the future, in accordance with all enlightened industrial policy. (2) Your Science Advisory Board of p[...] nent engineers and scientists recommended that atte[...] be given to development of scientific knowledge on [...] can be built the new industries, so urgently desire[d] [by] your administration to provide employment. (3) Va[...] groups urged that the present efforts to aid the farm[er be] supplemented by a really adequate attempt to create [new] markets for farm products through discovery of [new] industrial uses for these products through rese[arch]. None of these recommendations was acted upon. [(4)] Your letter to us calls attention of the public to [the] "dislocations" produced by science, and quite pro[perly] calls on us to try to cure them, but it does not indi[cate] interest in the creative work and permanent values w[hich] engineers and scientists continue to regard as their [...] contributions to social welfare.

My colleagues and I will do everything in our pow[er to] deal with the situations which you have called to our [at]tention: reciprocally we most respectfully urge you [and] your colleagues in the government to put science to w[ork] more effectively for the national welfare, and to [en]courage its activities in all three of its principal setti[ngs] —in governmental bureaus, in industry and in educati[onal] institutions.

Since your letter was received through the press, i[t is] evidently your desire to call these issues to the attent[ion] of the public generally. I assume, therefore, that ther[e is] no impropriety in my replying *via* the same route.

SPECIAL ARTICLES

THE HINGHAM RED FELSITE BOULDER TRAIN

IN the northern part of the town of Hingham, Massachusetts, is an area of banded red felsite, fragments of which were carried away by the ice-sheet and deposited in a fan-shaped boulder train that extends southeastward for many miles. In 1904 Professor W. O. Crosby published a map of part of this train extending about six miles from its source. For many years the writer has been mapping the locations of several hundred specimens of red felsite found by him within eight miles of the source. In 1933 two were found in a distant part of Marshfield and later search has revealed others on Cape Cod, Martha's Vineyard and Nantucket, to a maximum distance of eighty-five miles from the source.

As long ago as 1833 Professor Edward Hitchcock found bold outcrops of this rock, which he described "as in the form of ridges." In 1904 Professor Crosby mapped three neighboring ledges, two of which have since disappeared. The only remaining one is small in area and does not stand above the ground surface. There are, however, in that vicinity long walls and ornamental gate posts built entirely of the red felsite.

The rock, which has been called by some geolog[ists] the most beautiful in Massachusetts, is deep red[dish] purple, compact and almost flinty, and contains sc[at]tered, dull yellow lenticular masses about half an i[nch] long. Weathered surfaces show a distinct flow-str[uc]ture marked by parallel thin discontinuous sheets [or] flat lenses of compact red material in a gray or pink[ish] matrix that is shown by a lens to have a similar flo[w] structure but on a much smaller scale. Abundant sm[all] phenocrysts of quartz and a few larger ones of fe[ld]spar are scattered in an aphanitic ground-mass, b[ut] there are no other distinguishable minerals. The ex[act] sort of rock has not been determined microscopical[ly], but it is probably a rhyolite or a dacite. As it contai[ns] small fragments of rocks of other sorts as well as the red felsite itself, it is clearly a flow-breccia. It [is] not much roughened by weathering, but the dark po[r]tions are often left in relief, and it is easily disti[n]guished from other rocks. It was one of the favor[ite] materials used by the Indians in making arrow a[nd] spear heads.

The margins of the boulder train diverge sout[h]eastward, the angle between them being about 60

northern margin reaches the coast in about ten , at the entrance to Scituate Harbor, south of h place specimens of the red felsite are abundant e drift, but none have been found north of a line n from the source of the boulders to the harbor nce. The western margin reaches Vineyard d in Falmouth, fifty miles from the starting point. imens of red felsite were found in abundance g the western margin and to the east of it, but west of it either on the surface or in the numerous el pits seen in the first eighteen miles south of the e of the train.

FIG. 1

f the lines delineating the margins of the fan be olonged southeastward, the area between them will lude all Cape Cod, all Nantucket and the adjacent nds and the eastern half of Martha's Vineyard. ecimens of the red felsite have been found in all se localities, but none have been found after orough search in the western half of Martha's Vine-rd. It is interesting to note that the part of that and in which fragments of red felsite have been und is the part that was occupied by the Cape Cod y lobe of the ice-sheet at its greatest extension, and t the Buzzard's Bay lobe which deposited the oraine in northwestern Martha's Vineyard did not rry any of the Hingham red felsite. The western rgin of the boulder train reaches the Vineyard out two miles westward of West Chop, the northern-st point of the island, in the interlobate moraine.

The western boundary, according to specimens found, is a consistently straight line and apparently marks the boundary of the fan-shaped train in the early stages of glaciation, and also approximately the boundary between the lobes of the ice-sheet at that time.

Farther east a moraine, of which the Manomet Hills of Plymouth are salient features, is plainly an inter-lobate moraine dividing the two lobes in the last stages of glaciation. This moraine begins with the hills of Marshfield and continues with the Manomet Hills, which extend southward nearly to the Cape Cod Ship Canal. South of the canal a distinct moraine extends as far as Woods Hole. On Martha's Vineyard the original boundaries seem to have prevailed.

It seems reasonable to assume that the Buzzard's Bay lobe pushed a part of the Cape Cod Bay lobe some ten miles or more eastward without carrying away all the red felsite specimens previously deposited, and that both lobes then shared in forming the prominent moraine which now marks the division between their areas.

Professor Kirk Bryan has pointed out that speci-mens are absent in the areas of three spillways which existed in the melting stages of the ice-sheet. One of these occupied the low plains in Kingston, another followed the depression now occupied by the Cape Cod Ship Canal, and the third was in the region of Bass River and Dennis. Search was made in these locali-ties, but the soil there is sandy without good exposures of gravel. Apparently whatever specimens existed there were swept away by the currents of glacial streams. I wish also to acknowledge valuable sugges-tions given me by Dr. Laurence La Forge.

In searching for specimens on Nantucket, the writer was assisted by Professor William F. Jones, formerly of the Massachusetts Institute of Technology, who pointed out that the easternmost part of Nantucket bears an interlobate moraine continued southward from the forearm of Cape Cod, which was a boundary between the Cape Cod Bay ice lobe and the South Channel ice lobe, which occupied what is now sea bottom east of Nantucket. Specimens found at Cos-kata, Sankaty and Siasconset are in the area assigned to the South Channel lobe. No geologist whom the writer has consulted knows of any area in southeastern New Hampshire or northeastern Massachusetts, over which districts the ice of the South Channel lobe must have passed, in which red felsite similar to that of Hingham is now exposed. Seemingly the ice of the Cape Cod Bay lobe at one time extended farther east over land later invaded by the South Channel lobe, which picked up material earlier deposited by the Cape Cod Bay lobe and carried it farther on.

In the more distant parts of the boulder train material was collected by the writer only where it was found in place in gravel pits and road cuts. Beach pebbles, which might have been brought by floating ice, were disregarded. On Cape Cod some gray and greenish-gray specimens were found whose structure is identical with that of the Hingham red felsite. Some of these when broken are purplish within and some are gray throughout. Whether or not these are weathered fragments of the Hingham red felsite is immaterial, as numerous pebbles of the typical red felsite were found in the same places.

In Hyde Park, fifteen miles west of the Hingham locality, are some exposures of red felsite that are part of the Mattapan volcanic complex. The rock found there is less strongly colored than that from Hingham and differs from it in the details of flow-structure. The two sorts of rock are easily distinguished. The boulder train extending from the Hyde Park area is rather scanty, and no specimens that could have been carried from there by the ice were found near the western margin of the Hingham boulder train.

The line of the terminal moraine in the northern part of Nantucket (about 83 miles from the source in Hingham) is usually recognized as the limit of the farthest advance of the ice in that locality. Specimens found south of the moraine were probably transported by streams flowing from the ice and deposited in the outwash plain. They are not technically in the boulder train and should not be so considered unless it can be shown that they were deposited by the ice of a previous glaciation or by a possible over-riding of the ice contact by the last glacier.

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PRELIMINARY STUDIES OF A CEREBRAL DISORDER OF YOUNG CHICKENS[1]

A disorder of chicks characterized by nervous involvements was observed on a number of poultry farms in Rhode Island during the past winter and spring. The disease appeared to be quite wide-spread over the state, and reports from other sections of New England would indicate that a similar difficulty was experienced by poultry growers in these sections.

The symptoms of the disorder resembled those described by Pappenheimer[2] and Dunlap[3] to a considerable extent. The only characteristic and consistent lesions were those of the brain in which the cerebellum was most often involved. This portion of the brain on gross examination showed edema and swelling with visible gross hemorrhages of the tissue. In some instances the same type of lesions was also noted in the cerebrum.

Observation showed the disease to be most prevalent between the ages of three to six weeks, although it has been observed by the writers in chicks as young as 16 days old. Since it appeared to involve the fastest growing chicks of the lot, it was found more frequently in cockerell than in pullet chicks. The disease outbreak showed a rather sudden onset.

Cultures made from the brain and other tissues on various types of media remained sterile and suspensions of macerated brain tissue inoculated intravenously, subcranially and subcutaneously failed to incite symptoms of the disorder. Since no growth was produced on cultural media and attempts to produce the disease by inoculation had failed, it would appear that the condition was not one of an infectious nature but probably one of a nutritional type. It was observed in the field under a wide variation of management conditions, feed mixtures, breeds and strains of stock, and as a result presented a confused picture as to the possible cause of the disease.

Since an unusual situation existed during the year with respect to the quality of ingredients available for feeding purposes in comparison with previous years, indication tests were inaugurated with the hope that they would shed some light on the problem. The rations comprised various types of mixtures where some particular ingredient formed the major portion of the mixture and in some cases a deficiency ration was employed.

In only one group did the typical nervous symptoms and lesions develop. This group had been fed a ration composed of:

72.4	pounds	yellow corn meal
22.0	"	dried skim milk
2.2	"	calcium carbonate
1.1	"	sodium chloride
2.2	"	cod-liver oil

This ration produced a mortality in this group of chicks of 50 per cent., half of which showed the typical brain lesions upon autopsy.

The high corn ration was compounded on the basis that the 1935 corn crop seemed to be somewhat unusual from the standpoint of uniformity in view of its poor quality as evidenced by poor germination and high moisture content. A repeat trial is being inaugurated for confirmation purposes.

[1] Published by permission of the Director of Research as Contribution No. 495 of the Rhode Island Agricultural Experiment Station.

[2] A. Pappenheimer and M. Goettsch, *Jour. Exp. Medicine*, 53: p. 11, 1931.

[3] Glen L. Dunlap, *Jour. Amer. Vet. Med. Assoc.*, 80, n. s. Vol. 33, No. 6, pp. 880–885.

SUMMARY

Chicks fed a diet in which corn was the principal ingredient, in contrast to other rations employed, were the only ones in which the typical nervous disorders were noted and typical brain lesions observed upon autopsy.

The preliminary data at hand, although not of a definite nature, would seem to indicate that some factor or factors of the corn used were responsible or at least contributory to this disorder.

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THE INSECT VECTOR FOR THE NATURAL TRANSMISSION OF EPERYTHROZOON COCCOIDES IN MICE

IT has been recognized since 1930[1] that the white mice used for experimental purposes in this country may harbor a latent blood infection which is distinct from *Bartonella muris* but which like it is activated by splenectomy. The infecting organism, *Eperythrozoon coccoides,* was first described two years previously in Berlin.[2] It is a small ring-shaped body, usually less than 1 μ in diameter, staining reddish blue by Giemsa or Wright's stain. It appears in great numbers on the red cells as well as in the plasma within one to several days following splenectomy of the carrier animal. The fact that normal carrier mice are apparently little affected by the organism and that (unlike *Bartonella muris* infections) the multiplication of the parasite following splenectomy results in no marked pathological change, has led to a rather general oversight of the possible influence of the *Eperythrozoon* on experimental results. Certain changes in the blood picture and in the size and histology of the spleen in the infected animal have recently been demonstrated.[3,4] These deviations from normal may be sufficiently great at times to be significant when exact studies on the relation of the spleen to disease and resistance are under investigation.

The presence or absence of the latent *Eperythrozoon* infection can be demonstrated by splenectomy. The uninfected mice when kept isolated from other stock will remain free of the organism. The intraperitoneal injection of blood from a carrier mouse or from one showing active infection serves as a simple method for laboratory transmission. The means for the natural transmisison of the parasite from mouse to mouse has not been recorded up to the present time. The fact that the *Eperythrozoon* is a blood parasite and that it spreads gradually but surely through a colony of mice kept under the usual laboratory conditions points to the rôle of an insect vector in its natural transmission. Negative results have been reported with the rat louse and with fleas.[1,5,6] By analogy with the natural transmission of *Bartonella muris* this vector might be suspected to be the mouse louse.[7] A series of simple experiments revealed that the louse *Polyplax serrata* does indeed serve as the insect vector of *Eperythrozoon coccoides* from mouse to mouse.

A group of mice known to be free from latent *Eperythrozoon* infection was splenectomized and kept in rigid quarantine. These served as the susceptible hosts for the transmission tests. The more commonly occurring ectoparasites in an infected colony of mice were identified and used for the transmission experiments. There were no fleas in this infected colony. The two species of mites tested, *Myobia musculi* and *Mycoptes musculinus,* failed to transmit the *Eperythrozoon* by feeding on the test host.

The experience with the louse *Polyplax serrata* was quite different. In each of eleven experiments the adults and nymphs were shown to be capable of transmitting *Eperythrozoon coccoides* to the uninfected test host by feeding on it. The organisms appeared in the blood of these splenectomized animals in from nine to seventeen days, depending on the conditions of the experiment. In two other trials in which the adult lice were kept away from the host for several hours, transmission failed to take place. The nymphs from the same host, however, that were starved for the same length of time were capable of transmitting *Eperythrozoon.* These results suggest that the strong digestive fluids of the adult louse destroy the organism, while the less active alimentary juices of the nymph permit longer survival. The details of these and other experiments are to be reported later.

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6 D. Weinman, Amédée Legrand, Editor, Paris, 1935.
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VISCERAL LEISHMANIASIS IN BRAZIL

THE viscerotomy service of The Rockefeller Foundation detected, between March, 1932, and July, 1936, eighty-five specimens of liver containing leishmania bodies morphologically identical with those of *Leishmania donovani,* which produces Indian and Mediterranean kala-azar. These bodies and the liver lesions

were first described by H. Penna, of the yellow fever service.

In the last five months we have been able to investigate the disease clinically and epidemiologically, as well as to study the parasite in some of its morphological and biological aspects.

Clinically, the evolution of the disease is very similar to that of kala-azar: onset with fever of varying types, progressive emaciation, progressive anemia of a hypochromic type, leucopenia with relative monocitosis and rapid enlargement of liver and spleen. Hemorrhagic symptoms of mucosae are common. No skin lesions or skin color changes have been detected. Some cases have an acute evolution, with death occurring in from one to three months; others have a chronic course, with death occurring, in general, in from eight to fifteen months.

Parasites can be found rather easily by liver and spleen punctures and have also been detected in blood smears after white cell concentration. In human organisms parasites are always found in the form of leishmania, measuring from two to three micra, generally contained in the plasm of macrophages. Cultures have been obtained from spleen punctures in Noguchi and NNN mediums. Leptomonae grow and multiply abundantly in cultures, and their shape is identical with that of *Leishmania donovani*. Experiments are being carried on for identification of the species through comparison with all other known species of the genus *Leishmania*.

The formol-gel reaction has given fairly good results for diagnosis of clinical cases. Visceral lesions vary according to the chronic or acute evolution of the cases. In acute cases, hyperplasia of endothelial cells with monocitic infiltration, focal or generalized, is the principal sign, with a large number of parasites in mononuclear cells and extensive fatty degeneration. In chronic cases, fibrous lesions are dominant, with focal or generalized sclerosis, and a smaller number of parasites.

The disease has been found in almost all northern and eastern states of Brazil, and more recently, by Dr. Romaña, in the Argentine Chaco. No epidemic incidence of the infection has been found in any focus, but the disease exists endemically with scattered cases. No case of infection has been seen in towns, but investigation has shown the existence of jungle infection as a rule. Animal reservoirs of parasites are now being sought. Species of *Phlebotomus* have been found regularly in every focus.

The incidence of the disease, according to age, has been found to be as follows:

Under 6 years	53.1 per cent.
6 to 10 "	17.4 " "
Over 10 "	29.9 " "

Cases have been found in persons between the ages of 45 days and 56 years. Mortality investigation in some foci has shown a leishmaniasis death rate of 1.8 in the Amazon Valley, and one below 0.4 in the northeastern section of Brazil.

The treatment of clinical cases with antimonium derivatives—Neostibosan and Fuadine—has proved to be efficient.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE DETERMINATION OF THE INTERNAL GASES OF PLANT TISSUES

MAGNESS[1] has described a method of extracting the internal gases of plant tissues, uncontaminated by air, by submerging the material in mercury in a special tube to which is attached a mercury leveling burette that may be lowered to create a partial or almost complete vacuum in the tube containing the material. The gas escapes from the tissues, collects over the mercury and is then analyzed by means of the Bonnier-Mangin gas analysis apparatus.

The writers, in carrying out a large number of routine analyses, found the use of the Bonnier-Mangin apparatus rather tedious and time-consuming. It is frequently necessary to check the results several times to be certain of the accuracy of the values obtained. Consequently the Bonnier-Mangin apparatus was discarded and an Orsat gas analysis apparatus was used instead.

In order to make satisfactory determinations with the Orsat apparatus larger quantities of gas are necessary than is the case with the Bonnier-Mangin apparatus. To obtain an appropriate quantity of gas a larger extraction cylinder was provided. This was constructed in the laboratory by taking a piece of heavy-walled (2 or 3 mm) Pyrex glass tubing 35 mm in inside diameter, bending it at a right angle near one end and drawing it out to a nozzle to which a piece of heavy-walled rubber tubing was attached. A 1-liter aspirator bottle was attached to the other end of the rubber tubing, which served as a leveling bulb. The other or upper end of the glass tube was provided with a rubber stopper fitted with a capillary stopcock.

[1] J. R. Magness, *Bot. Gaz.*, 70: 308–316, no. 4. Illus. 1920.

A rather long rubber stopper was used and the small end was hollowed out into a short funnel with the end of the glass tube set flush with its bottom in order that the entire amount of gas could be driven from the tube by the mercury as the leveling bulb was raised. The glass tube was wrapped tightly at the upper end with adhesive tape to insure it against breakage as a result of the pressure exerted by the rubber stopper. The extraction cylinder is illustrated in Fig. 1. It was

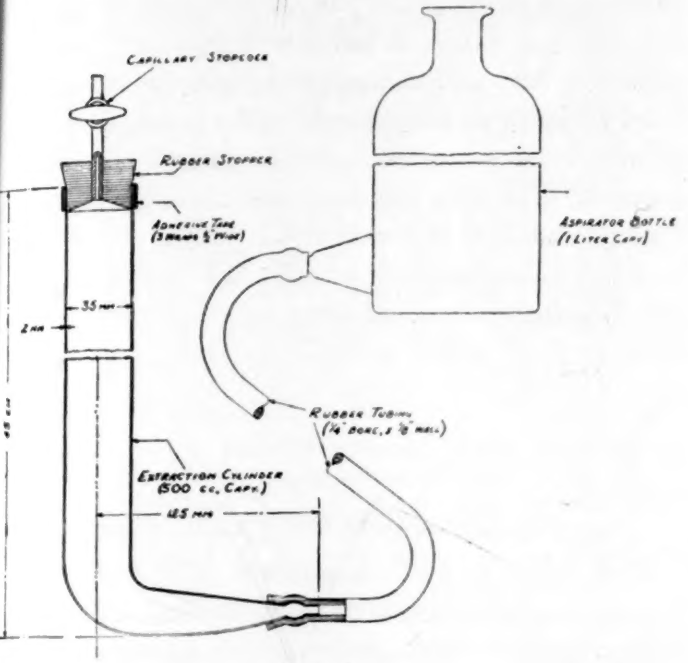

FIG. 1

45 cm. long and its capacity was approximately 500 cc and thus held sufficient material so that 10 to 15 cc or more of gas could be extracted at one operation. However, the cylinder may be made of any desired capacity. The danger of leakage appears to be no greater than with the Magness apparatus, and the connections can all be tested readily by repeated lowering and raising of the leveling bulb before the plant material is introduced. The extraction tube or cylinder may be made with a ground glass stopper as in the Magness apparatus if this modification is preferred.

After extraction the gas is transferred to the gas burette of the Orsat apparatus and its volume determined. It is then analyzed in the usual manner. In most of the tests the writers have used a 25 cc burette in place of the 100 cc burette regularly supplied with the Orsat apparatus, but a 10 cc burette may be used if only a small volume of gas is available. A 10 cc graduated pipette can be used for this purpose. If the material yields very small amounts of gas the gas obtained may be transferred to a Hempel-Winkler gas burette and stored until other extractions are made which may then be combined and analyzed. The absorption of the carbon dioxide and oxygen are carried out as in an ordinary gas analysis determination. Unless the capillary tube in the manifold of the gas analysis apparatus is very small, it may be advisable to correct for the volume contained in this capillary or manipulate the apparatus in such a manner that none of the extracted gas is in the capillary when a reading in the burette is made. In certain work where extreme accuracy is not required, acidulated water may be used in the measuring burette of the Orsat apparatus instead of mercury. This is somewhat more convenient.

The precautions to insure that the gas sample is not contaminated with the atmosphere are the same here as described in the Magness apparatus.

In working with pears about 250 grams of suitably shaped pieces were rapidly cut and dropped into the extraction cylinder. The leveling bottle containing mercury was then raised and the air in the cylinder driven out at the top through the capillary stopcock. The stopcock was then closed and the leveling bottle lowered about 10 inches for a few seconds and then raised. The gas thus collected was discarded, as some of it was at the surface of the tissue and may have been contaminated with outside air. The stopcock was then closed and the leveling bottle was lowered and held about 30 inches from the bottom of the extraction cylinder. The length of this extraction period was standardized at 5 minutes. It may prove desirable to construct a special cork borer of a size suitable for the material and apparatus and force the plugs of tissue out under the mercury in a manner similar to that suggested by Magness instead of filling the cylinder with pieces of tissue in the manner described.

The apparatus has been successfully used with eggplant fruits, pumpkins and Kieffer pears, with duplicate determinations checking very closely. The amount of gas in the eggplant fruit is 15 to 30 per cent. of its entire volume. The amount in the Kieffer pear is less than 1 per cent. of its volume. The successful use of this procedure with tissues of such extreme differences in their gas content indicates that the method is applicable to a wide range of tissues when a large quantity of the material is available. In the hands of the writers, at least, the proposed procedure has proved to be much less time-consuming and more reliable than the Bonnier-Mangin apparatus. It requires about 15 to 20 minutes to prepare the material and extract and analyze the gas by this method. It can not be used, however, when only very small amounts of material are at hand.

It may be noted that in the analysis of some fleshy fruits and vegetables the oxygen content of the gas in the tissues is much nearer the oxygen content of the air than might be expected. This is evidently due to the greater solubility of oxygen than nitrogen in the water contained in plant tissues. Thus the percentage of oxygen in air dissolved in water is around 34 to 35

per cent. at temperatures of 0° to 20° C.,[2] whereas the percentage of oxygen in normal atmosphere is around 21 per cent. In studying the gases obtained from fruit and vegetable tissues many investigators evidently consider that the gas obtained by subjecting the tissue to a partial or almost complete vacuum is obtained only from the intercellular spaces. According to Henry's law,[3] the concentration of the dissolved gas in solution is directly proportional to the concentration in the free space above the liquid. It is evident that in subjecting tissue to a partial vacuum considerable amounts of gas are extracted from the liquid contained in the cells as well as from the intercellular spaces. Magness[4] has mentioned this possibility. The difference in solubility of gases would also account, at least in part, for the very high CO_2 content in tissues after exposure to a much lower concentration of CO_2, as it is much more soluble in water than either O_2 or N_2. The writers have found that exposing Kieffer pears to an atmosphere containing 5.3 per cent. CO_2 at 60° F. resulted in the presence in the internal gases of 36 per cent. CO_2, whereas the gases from check lots in normal air had 18.6 per cent. Gerhardt and Ezell[5] obtained nearly 80 per cent. CO_2 from the gas of Bosc pears after a 24-hour exposure of the fruit to 35 per cent. CO_2 at 65° F. The gas extracted from Jonathan apples subjected to the same treatment contained nearly 50 per cent. CO_2. The higher CO_2 content in the gases obtained from pears was probably due to a higher proportion of the gas being extracted from the liquid contained in the fruit, as there is less intercellular space in pears than in apples.

It is possible that the gases dissolved in the solution within the cell are of more physiological significance than those contained in the intercellular spaces, as the dissolved gases are in more intimate contact with the protoplasm. For example, Heilbrunn[6] considers that the negative charge on the surface of protoplasm is due, at least in part, to the diffusion of carbonic acid from the interior of the cell.

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[2] C. D. Hodgman, "Handbook of Chemistry and Physics." Twentieth edition, pp. 890–891. Chemical Rubber Publishing Company, Cleveland, Ohio. 1935.

[3] F. H. Getman and F. Daniels, "Outlines of Theoretical Chemistry." Fifth edition, p. 141. John Wiley and Sons, Inc. New York. 1931.

[4] *Loc. cit.*

[5] F. Gerhardt and B. D. Ezell, SCIENCE, 80: 253–254, 1934.

[6] L. V. Heilbrunn, "The Colloid Chemistry of Protoplasm." Colloid Symposium Monograph. III: 135–151. 1925.

MANGE IN GUINEA PIGS

IN SCIENCE, for March 27, 1936, there appeared a short article on "Sulphocyanate Treatment of Mange in Guinea Pigs."[1] A safe and simple procedure has been used in our laboratories in treating mange in guinea pigs, rabbits and dogs. Raw linseed oil is applied to infected areas or the entire body, using a soft two-inch paint brush. The treatment is repeated at intervals of a few days. The animals "shampoo" themselves thoroughly; the oil absorbed is nutritive and mildly laxative. Hairs seemingly not infected will fall. We have had animals, completely denuded, make good recovery in body weight and return of good hair growth after treatment. Boiled linseed oil must not be used. The idea was borrowed from the custom of feeding flax seed to horses in the early spring in order to aid shedding of their winter coats of hair and from the fact that linseed oil is an excellent detergent for body surfaces soiled by heavy greases.

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PROTECTION OF EYEPIECES

THE upper lens of some makes of microscope eyepieces is set below the level of the surface of the casing for protection. Unfortunately, this also renders them very difficult to clean properly. Much of this cleaning can be avoided if a circular cover-slip 20 to 25 mm in diameter is placed on the upper surface. These cover-slips are easily removed and polished and will not interfere perceptibly with the use of the instrument. The rim of the eyepiece prevents them from sliding off when the microscope is tilted.

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PITTSBURGH, PA.

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